JUSTIFICATION FOR OTHER THAN FULL AND OPEN COMPETITION

for the

SPACE LAUNCH SYSTEM STAGES

JUSTIFICATION FOR OTHER THAN FULL AND OPEN COMPETITION (JOFOC)

1. **Agency and Contracting Activity.** The procuring agency is the National Aeronautics and Space Administration (NASA), and the contracting activity is NASA's Marshall Space Flight Center (MSFC).

2. **Description of the Action.** NASA's MSFC proposes to modify contract NNM07AB03C with the Boeing Company located at 499 Boeing Boulevard in Huntsville, Alabama for the Space Launch System (SLS) Core Stage and Upper Stage (US). This effort is from Authority to Proceed (ATP) through completion of Design, Development, Test, and Evaluation (DDT&E), including the Stage hardware, the activities, and the operations required for early missions of the SLS. This justification is required to modify the Ares I Upper Stage (Ares US) contract with Boeing because the SLS requirements are not currently within the general scope of the Ares US contract. Approval of this JOFOC will allow the Core and Upper Stage (collectively referred to herein as "the SLS Stages" or "the Stages") to begin concurrent system design immediately.

   The anticipated period of performance for the SLS Stages contract is from the date of contract execution through December 31, 2021. The current Ares I Upper Stage Production contract period of performance is from September 1, 2007 through June 18, 2018.

   While the basic nature of the Ares US and SLS Stages development and production work is substantially the same, the Stages period of performance must be extended by approximately 3 years due to the change in architecture and available budget, which altered the flight manifest schedule. Also, due to the different requirements for SLS, there were additions and deletions as compared to the Ares US. For instance, the SLS Stages do not use some systems that were planned for development on Ares US, including common bulkheads, Reaction Control Systems, Ullage Settling Motors, new Thrust Vector Control development (Core will use Shuttle heritage hardware), and Separation Motors; the elimination of these development efforts will reduce the overall SLS Stages development cost compared to that of Ares US. However, offsetting these cost reductions are increases due to moving from the smaller length and diameter of the Ares US to the larger SLS Stages.

   The current value of the Ares US contract is $1.5B. Comparing this value with the expected value of the SLS Stages effort, the change in value between the two can be attributed to the following factors (all changes are with respect to Ares US as the point of reference):

   - Ares US contract does not include full development by Boeing - (increase)
   - Ares US contract has different flight rates – (decrease)
   - Ares US contract does not include a Core Stage – (increase)
   - Ares US Stage has different requirements –(decrease)

3. **Description of Supplies/Services Being Acquired.**

3(a) SLS Architecture: Consistent with the NASA Authorization Act of 2010 and Presidential direction, NASA is developing a set of reference missions that rely on evolving a set of development and operational space launch capabilities over a period time to support increasingly ambitious exploration missions to increasingly more challenging destinations. (Reference missions define missions that NASA intends to perform, including the means of launching those missions, leading directly to a set of launch vehicle needs.) A key early capability required by NASA's reference missions is the Orion Multipurpose Crew Vehicle (MPCV) and a human-rated Space Launch System. MPCV provides crew accommodations, propulsion, and communication for extended exploration missions. Early SLS missions will launch the MPCV for high energy (i.e., higher orbit than Low Earth Orbit or LEO) un-crewed test flights and Beyond Earth Orbit (BEO) crewed operations. An early milestone is an exploration test flight of the SLS that has enough lift capability to launch the MPCV with a propulsive in-space stage. This mission will allow MPCV to go beyond LEO and return with enough velocity to fully test the MPCV heat shield. The lift capability required for this flight is approximately 70 metric tons to LEO.

NASA's reference missions also require a launch system capable of lifting up to 130 metric tons of payload to LEO for more ambitious exploration missions. The larger payloads enable placement of significant exploration hardware in space and enable potential science missions to Near Earth Objects, such as asteroids, and Mars. The SLS design will be capable of evolving to this capability (stage will be designed to be reconfigurable without performing design analyses) at a pace prescribed by the available budget.

The SLS Program Office has worked to develop a launch system architecture to meet an evolving capability strategy consistent with the reference missions. NASA selected a launch system that incorporates Liquid Oxygen (LOX) and Liquid Hydrogen (LH2) propulsion technology for the Core Stage and mature five segment solid motor technologies for the boost phase on the initial test flights. The vehicle uses a "stage and a half" configuration that ignites the Core Stage engines seconds before liftoff and then ignites the solid motors at liftoff. The boosters burn out approximately two minutes into the flight while the Core Stage engines continue to burn until the desired cutoff point is achieved. This basic configuration is flexible for both early flight demonstration with MPCV and for evolving to a 130 metric ton launch capability using a single Core Stage development that results in a common Core Stage for any SLS mission.

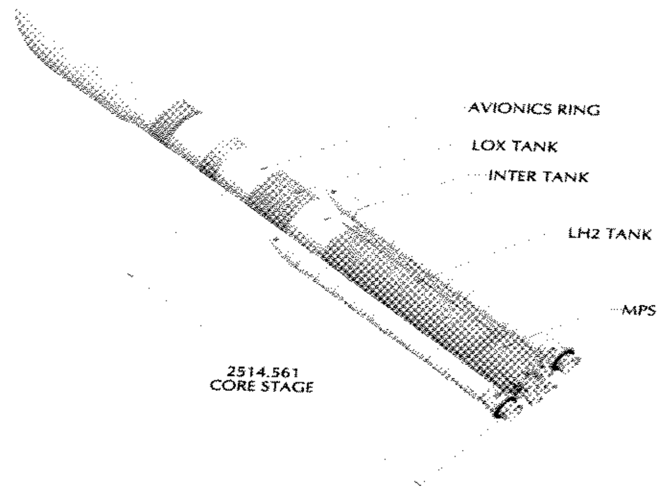

Figure 1: Launch configuration (shows upper stage as well)

The main Elements of SLS are divided along the major hardware components, and also constitute "projects" within the SLS Program. The early SLS configuration will incorporate the RS-25 engine as the Core Stage main engine. The RS-25 was selected because of the experience with this propulsion system on the Space Shuttle program, the performance of the engine, and the availability of engines from the Space Shuttle inventory. The RS-25 will be used "as is" (no new qualification or requalification except for minor changes due to obsolescence, like replacement of the engine controller electronics box, and qualification test firing at the Stennis Space Center). The booster configuration selected for the early SLS flights consist of two boosters derived from the Ares I Reusable Solid Rocket Motor V (RSRMV) project; the "V" indicates a five segment motor configuration. These boosters were selected for similar reasons to the RS-25. The development of the motor components is nearly complete, with few technical risks remaining, and boosters can be available in time to support the launch schedule due to use of Shuttle heritage Forward Skirt, Aft Skirt and interface hardware, and the use of mature Ares I booster avionics. Avionics and software will be developed using, with some modifications, the Ares I Instrument Unit Avionics systems and Flight software that has been previously developed by an in-house NASA design team. System Integration of the integrated stages and boosters will be provided by an experienced NASA engineering team consisting of NASA personnel from MSFC, Kennedy Space Center, Johnson Space Center, Glenn Research Center, and Langley Research Center as well as support contractor personnel.

The only remaining major SLS flight element needed for the early flights required to be developed is a Core Stage, which forms the backbone of the SLS launch vehicle configuration. In its most basic form, the Core Stage consists of structural tanks and dry structure, Main Propulsion System (MPS), thrust vector control for the SLS engines (RS-25), and attitude control systems. Even though the missions are different, the general functionality between the Ares Upper Stage and the SLS core stage is the same in that both stages provide large volume cryogenic (LOX/LH2) storage and fluid delivery to an engine complement. Additionally, both stages contain similar components and thereby would utilize similar, if not identical, supply chains.

<u>3(b) Description of Supplies/Services:</u> NASA's strategy for minimizing cost on SLS is dependent upon leveraging (capitalizing on effort expended on Ares 1 that can be used on SLS Core, thus saving that effort for SLS) common stage elements (Core and Upper Stage) and producing those stages using as much of the same tooling, processes, and procedures as practical. The new Upper Stage would incorporate the J-2X engine to leverage the development investment made under the Ares project. NASA has selected a common diameter, thermal protection approach, structural design philosophy, and avionics systems for both the Core and the Upper Stage. While SLS Upper Stage flight units are not needed as early as Core Stage units are, procurement of the Core Stage and the Upper Stage by the same prime contractor enables manufacturing efficiencies to be realized since these stages are greatly similar in overall scope, design, materials, and manufacturing processes. Utilization of common tooling, design and facilities will minimize both development and production costs. Both stages utilize similar supply chains; therefore, it is logical to procure these stages under one acquisition in order to realize streamlined efficiencies and maximize economies of scale, especially given the limited planned flight rate of SLS. DDT&E work on the Upper Stage will continue in parallel with DDT&E on the Core Stage up through the preliminary design review (PDR) for the Upper Stage. Although an Upper Stage is not currently planned or required for the initial test flights, continuing with Upper and Core Stage DDT&E in parallel will ensure that Core Stage work will directly contribute to reducing the costs of follow-on Upper Stage development, and that Upper Stage DDT&E beyond PDR can be accelerated if additional development budget becomes available. This commonality, coupled with a common prime contractor, will result in significant cost efficiencies associated with development and production of the Stages.

The Ares US contract was awarded to Boeing on September 1, 2007 on a competitive basis in support of the Ares I Project and Constellation Program. The current total contract value of the Ares I Upper Stage contract is $1.5B, of which approximately $394B has been expended. This effort was coupled with an in-house NASA design of a significant portion of the Upper Stage. The NASA design team total funded amount since project start supporting Upper Stage design is $726M. The total amount expended to date on the Ares US, including both NASA in-house design team and Boeing work, is approximately $1.1B.

Under the Ares US contract, prime contractor Boeing is maturing the NASA-led design and producing large cryogenic upper stages for Ares. This justification supports the transition of the Ares US efforts to the follow-on program, SLS, in accordance with the NASA Authorization Act of 2010. The upper stage of Ares I consisted of the structure, fuel tanks, plumbing, and propellant lines to fly a large cryogenic stage as a major element of a launch vehicle, which is the same functionality needed for both of the SLS Stages. The differences between the Ares US and the SLS Stages principally are changes in diameter and engine selection; however, technical progress to date on Ares (because of that same technical functionality) can be effectively leveraged to support the SLS Stages. The Boeing contract for Ares US is a large stage development effort with the same functionality needs as SLS Stages. The development phase is a critical period for SLS, whereby design trades and corresponding design maturation details will have a large effect on the long-term production and operations cost for these stages long after this phase has been completed. Boeing has been involved in analysis and provided support for decisions by the government on the Upper Stage for Ares and thus has unique and critical experience that is vital to expediting development of the SLS Stages.

The contractor will be responsible for the Core Stage and Upper Stage DDT&E, early mission manufacture and assembly, and integration of the stage engines. The contractor will provide the 8.4m diameter cryogenic Core and Upper Stage designs using LOX/LH2 fuel type. The SLS Stages will support an evolvable vehicle ranging from approximately 70 to 130 metric tons of payload to orbit. As Table 1 illustrates, a significant number of component designs on the Ares US contract have completed advanced development and PDR design (some even to and through CDR), and suppliers are performing under awarded subcontracts. As the prime contractor under the Ares US contract, Boeing has established effective supply chain relationships for the Ares US contract. NASA has expended considerable time and incurred significant cost as further detailed in Section 5 under the Ares US contract to work with Boeing as component subcontractors and suppliers were identified and approved.

Total Component Specifications	81
Component Specifications on Contract w/Suppliers	60
PDRs complete to date	44
CDRs complete to date	14

Table 1

The contract will be modified to direct Boeing to: 1) Modify current Ares Upper Stage Design to meet performance and configuration requirements for the SLS stages using RSRMV boosters in the initial configuration and either solid or liquid boosters for the final configuration; 2) Modify current Ares Upper Stage manufacturing and production system for a SLS Stages manufacturing and production system; 3) Produce qualification test articles and; 4) Produce flight stages for SLS in lieu of Upper Stages for Ares.

4. **Statutory Authority**. The statutory authority permitting other than full and open competition is 10 U.S.C. 2304(c)(1), as implemented by FAR 6.302-1, "Only one responsible source and no other supplies or services will satisfy agency requirements."

5. **Rationale Supporting Use of the Authority.** The rationale supporting use of 10 U.S.C. 2304(c)(1) is that there is a sound basis to conclude that the agency's minimum needs can only be satisfied by unique services available from one source with unique capabilities (reference FAR 6.302-1(b)(1)). Specifically, in accordance with FAR 6.302-1(a)(2)(ii)(A) and (B) and FAR 6.302-1(a)(2)(iii)(A) "Substantial duplication of cost to the Government that is not expected to be recovered through competition." and (iii)(B), "Unacceptable delays in fulfilling the agency's requirements" other than full and open competition is justified in this circumstance. (See 10 U.S.C. 2304(d)(1)(B))

(a) Unacceptable Delays

It is highly likely that award of a contract to a source other than Boeing for the SLS Stages work would result in unacceptable delays in fulfilling NASA's requirements. Contracting with Boeing for the development, manufacture, and assembly prevents unacceptable delays in fulfilling the Agency's requirements. Unacceptable delays in fulfilling the Agency's requirements for the SLS if a source other than Boeing were to perform the SLS Stages work would result from: 1) Significant critical path delay as a result of competition (12 months); and 2) formation of a new design/vendor supply chain (6 months), which would necessarily stretch out the development period to arrive at a Preliminary Design Review (PDR). The significant cost impact of this 18 month delay is described below, in the paragraph titled "Cost Impact of Significant Delay".

Significant Critical Path delay: Given the SLS program requirements and launch manifest in accordance with the 2010 NASA Authorization Act, the Core Stage effort defines the critical path for the first launch. In order to achieve the flight manifest date of 2017 with a goal of 2016, the following engineering steps must be accomplished:

- requirements development and allocation;
- Core Stage design and development;
- component design and procurement;
- manufacturing design and capability;
- qualification article production and testing; and
- flight vehicle manufacture and acceptance.

The design must be mature early enough to define facility modifications and tooling requirements that will then allow production of test articles, and finally production of the flight hardware. The planning schedule of the above tasks shown in Figure 2 is based on experience on the Ares project, in-depth studies during the SLS Requirements Analysis Cycle, and other NASA projects. Based on the best estimate of durations and dependencies among the tasks, the December 2017 early mission date is achievable (with some risk) if the effort can start immediately. The SLS Core Stage delivery is therefore on the critical path to meet the launch date commitment. Figure 2 shows the schedule, requiring the Structural Test articles to be started (procurements begun) before PDR, in addition to the first flight article to be started (procurements begun) before Critical Design Review (CDR). The specific subsystems that must be started before the design milestones will be carefully reviewed beforehand to ensure that they are ready ahead of the expected milestones. This schedule aggressiveness is meant to illustrate the schedule has no appreciable margin and cannot be compressed further to allow the time for a competitive selection and still meet the launch date. The time period between PDR and CDR is also aggressive, but it can be accomplished. The first Core Stage must be delivered to the Kennedy Space Center no later than September 2016 to support a December 2017 launch date. This schedule assumes authority to utilize the existing contract on or around October of 2011.

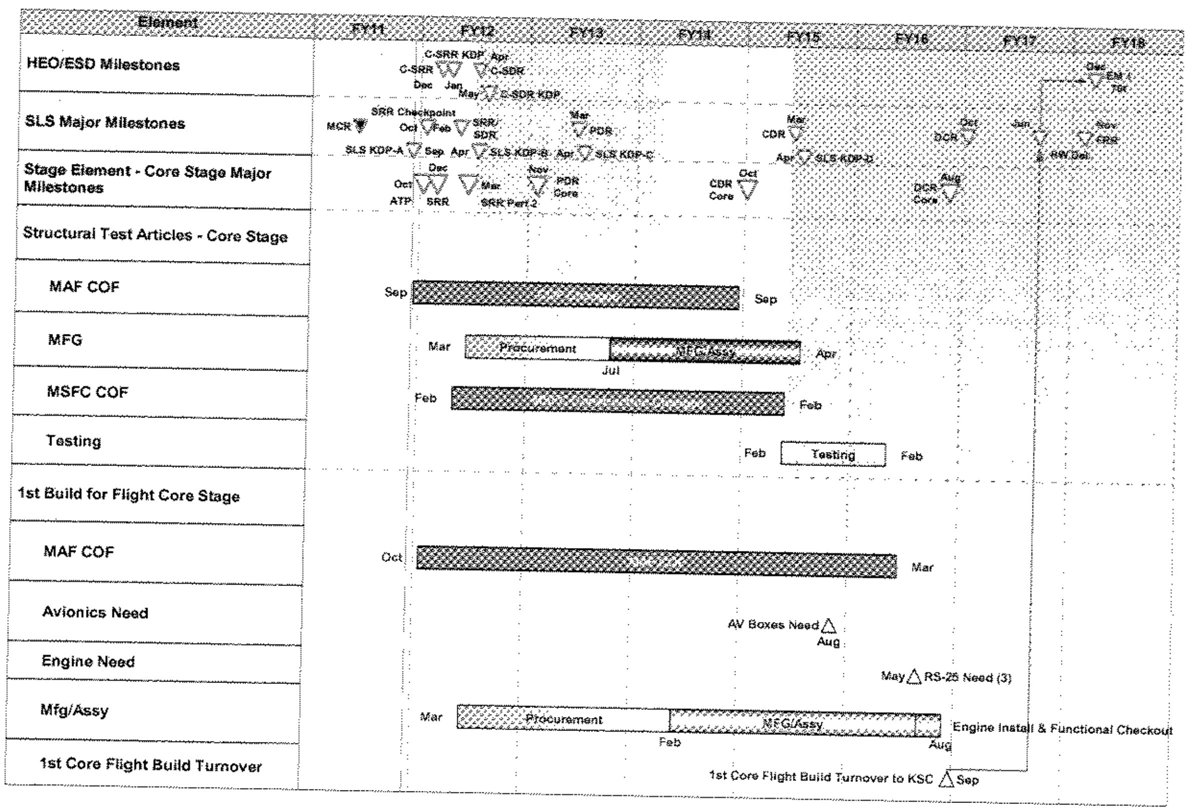

Figure 2: (Core Stage near term schedule)

As shown in Figure 3, the delay in a competitive Core Stage contractor selection versus utilizing the existing Boeing contract would result in an aggregate addition of roughly 18 months of total time to the critical path. Twelve months (mean/optimistic) of this delay derives from the acquisition duration inherent in a large open solicitation, overlaid onto the current program timeline. No work can be performed on SLS until the contractor receives Authority to Proceed (ATP). (While there is no set time period within a program's life cycle at which to begin to engage a contractor with a contract (and therefore an ATP), for a program that has established a schedule need date that sets an Element on a challenging critical path, the need is acute to set an ATP as soon as possible. This allows the earliest Contractor access to perform tasks on the critical path, which in turn allows for the best chance of meeting the schedule.) This twelve month estimate is based upon historical durations of large acquisition competitive selections. In contrast, modification of the existing Ares US contract with Boeing, as authorized by an Undefinitized Contract Action (UCA), would enable early work on SLS to be performed while a final contract modification is negotiated. Thus, unacceptable delays associated with a competition and award to another source would be averted by having Boeing perform the work.

New Design/Vendor Supply Chain: Six months of the total 18-month critical path delay explained above are attributable to lags in the early design activity along with establishment of a vendor supply chain that would be required in the case of a competitive procurement. This would be an additional 6 months of time that would need to be added to the PDR schedule from ATP should anyone other than Boeing be selected. That is to say, for a new competition, the duration from ATP to PDR would be 18 months; use of Boeing reduces to a 12-month duration between ATP and PDR. The driving factor in this 18-month duration to PDR for a new contractor is the MPS design, which is on the Core Stage Critical Path. This duration to PDR is vital to the overall critical path schedule and must be kept as short as possible to allow long lead procurements and tooling fabrication to begin and end at the right times. The components that make up that subsystem are largely unique, with very unique vendors.

As mentioned earlier, the SLS Core Stage development will dictate the critical path of the new SLS vehicle. Within the Core Stage, the critical path will depend on the Main Propulsion System (MPS), one of the subsystems within the Core Stage. The Main Propulsion System (MPS) is that subsystem on the Core Stage which receives propellant from the large cryogenic tanks and feeds those propellants to the engines for use. This critical path follows the development of the MPS, including the establishment of the MPS supply chain.

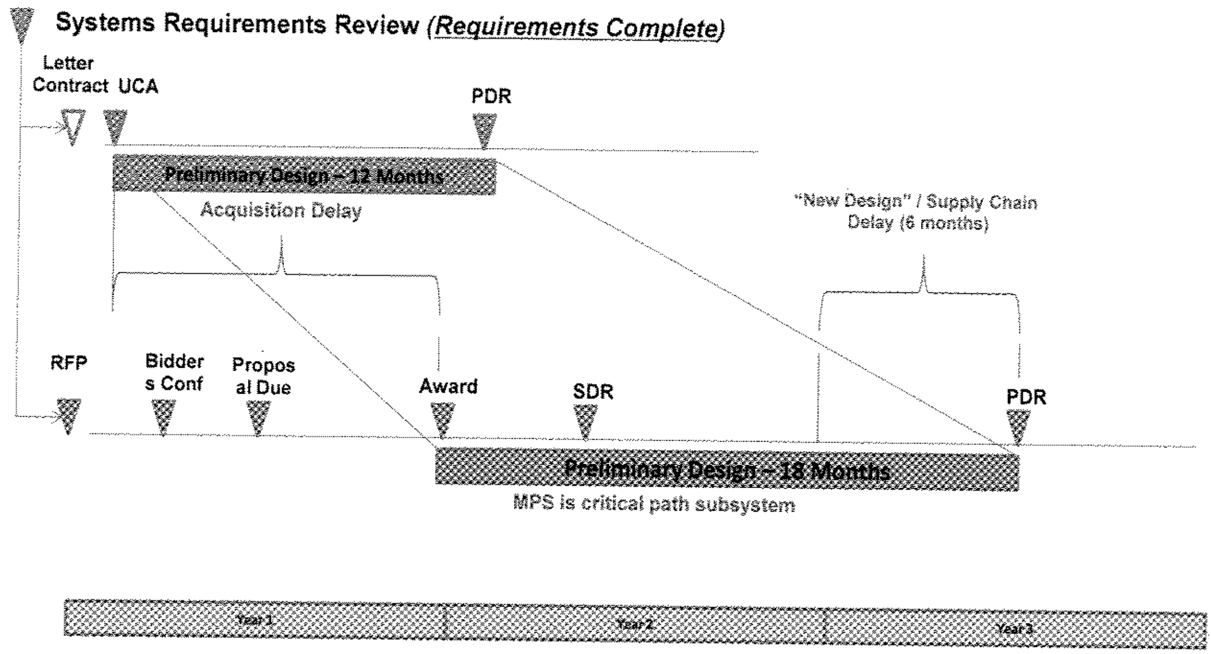

Figure 3: Delay due to competition

For a new MPS design, between ATP and PDR there is approximately 18 months of time required to:

- establish firm Stage architecture requirements (3 months),
- decompose Stage requirements and derive MPS subsystem and component requirements (3 months),
- secure, negotiate, and finalize vendor contracts (3 months) (It should be noted that the average time on Ares US from authorization to acquire a vendor and the time at which they were on-contract was 7 months.)
- iterate component requirements with the selected vendors (2 months)
- develop preliminary component designs (3 months)
- analyze designs against existing loads, engine interfaces, and environments (4 months)

It is estimated that this 18-month duration can be shortened to 12 months by utilizing the Ares US contract with Boeing, since all of the critical component vendors are not only on-board but are familiar with the design considerations and trade sensitivities for an MPS design, and are familiar with the NASA process (as it exists for Ares Upper Stage and will be similar for SLS Core Stage), and have component designs that can be used in part or in total on SLS Core Stage. For a Boeing MPS design, approximately 12 months is required to:

- update existing stage architecture, MPS subsystem, and MPS component designs concurrently with the vendors already on-board (5 months)
- develop/modify preliminary component designs (3 months)

- analyze designs against existing loads, engine interfaces, and environments (4 months).

Conversely, NASA has made large investments through Boeing under the Ares US contract to establish a supply chain to produce materials and components for the MPS (as well as for tanks, primary structure, and secondary structure,). Most of these vendors are capable of producing MPS hardware for the larger 8.4 meter diameter SLS vehicle. While a source other than Boeing might be able to perform all of the work necessary to support the PDR, it is likely that no source other than Boeing can do so in time to execute the SLS Stages development work in a manner that is not unacceptably disruptive to the program's critical path requirements. The reason that use of Boeing can shorten this 18-month time period from ATP to PDR to 12 months is that Boeing already has vendors on-board that have component designs that can be used in whole or in part to reduce the amount of work required to support a PDR.

Cost Impact of Significant Delay: The aggregate delay in the critical path to accommodate a new competitive acquisition translates into a "cost to first flight" impact of an estimated \$2.1B. Due to the slippage of the Core Stage readiness and the fact that the Core Stage drives the critical path, an 18-month delay in Core Stage delivery would result in a cost impact greater than \$1B for the SLS Program. Given that the first payload of SLS is an MPCV test flight, NASA would incur additional cost impacts to first flight due to the consequent delay and disruption to the other development programs with which SLS will interface (i.e., MPCV and launch capabilities at Kennedy Space Center). The delay and associated cost are based on the disruption of the other SLS Elements, MPCV, and ground operations. Accordingly, utilizing Boeing for SLS Stages avoids unacceptable delays in the first launch of SLS. Using Boeing for the SLS Stages preserves an earlier launch date and transfers the estimated \$2.1B cost toward subsequent flights, providing maximum benefit to NASA. Based upon evaluation of information from the SLS Broad Agency Announcement, coupled with an overlay of SLS requirements decomposed to identify what functions are needed and required by all the SLS Elements for the manifest, this delay would not be reduced in any competition scenario and therefore this additional \$2.1B cost would be incurred prior to the first launch.

<u>(b) Substantial Duplication of Cost</u>

Contracting with the existing Ares I Upper Stage source for the development, manufacture, and assembly of both the SLS Core and Upper Stages avoids substantial duplication of cost to the Government that is not expected to be recovered through competition. Cost not expected to be recovered through competition are: 1) stage production similarities; and 2) Main Propulsion System leveraging due to Ares US and SLS Core similarities

Stage Production Similarities: Because of the similarity between the Ares US and the SLS Core Stage (and SLS Upper Stage), there has been substantial work already performed with Boeing, and hence cost incurred by the government in developing a large cryogenic stage on Ares. A major part of this effort that has direct applicability to SLS is in manufacturing of the large components of the stage. Much of the effort to develop and produce a Core Stage for SLS has already been performed on Ares US, and so this cost would be duplicated in an open procurement scenario (potential recovery of costs in a competition are discussed in the Cumulative Cost Duplication section below). These efforts consist largely of tooling development, but also include process and weld schedule developments, tool qualification activities, mating precision equipment development, Thermal Protection System application process development, as well as various inspection technique developments.

For the SLS Core Stage, this stage production development effort can be divided into specific groupings as shown in Table 2. In other words, Table 2 lists all of the tasks (groupings) that would need to be performed in order to develop and prepare for SLS Core Stage production, but does not include the actual manufacturing of flight articles. Table 2 also shows a subdivision of groupings (i.e., subgroupings) within a group to provide a more thorough analysis of the effort and its cost in this Stage Production development work. For each subgroup, an estimate was made for how much additional effort would be needed by Boeing to complete the work for the Core Stage of SLS based upon how much work was done already on Ares US that was applicable to SLS Core Stage. Note that this does not imply that all (i.e., 100%) the effort performed on Ares US for Stage Production development is applicable to SLS Core Stage. Using a range percentage estimate (for example, between 33% and 66% on a given entry) of what Boeing has already performed and learned on Ares US for each of the entries in Table 2 compared to what would be needed to complete an SLS Core Stage by Boeing yields a savings of between $49M and $94M, which also equates to an equivalent cost duplication should this procurement be competed.

Note that since NASA cannot fully determine the exact details associated with the manufacturing development of the SLS Core Stage because the exact design of the Core Stage is not yet known to a significant detail, only a fairly good approximation (using ranges) of the effort associated with this work can be estimated. (Potential recovery of costs in a competition are discussed in the Cumulative Cost Duplication section below.)

Manufacturing Group	Major Production Operations (Subgroup)
Tank Assembly	Manufacture of Tank Components
	Friction Stir Welded Dome Assembly
	FSW of barrels and T-rings
	VPPA Major Weld
	Slosh Baffle Assembly
	Structual Assy and MPS Installation
	Pneumatic Proof Test
	Hydrostatic Proof Test
	External Clean/Prime/TPS
	Internal Clean and Protect
Intertank Assembly and Integration	IT Beam Assembly
	Stringer Panel Assembly
	IT Structural Assembly
	IT TPS
	IT Integration
Instrument Unit Assembly and Integration	IU Structural Assembly
	IU TPS
	IU Integration
	Integration of Avionics Boxes*
	IU Functional Test and Checkout
Propulsion Module Assembly and Checkout	Manufacture of PM Components
	PM Structural Assembly
	PM Heat Shield Assembly
	PM TPS
	MPS Component Manufacture
	PM Integration Functional Test and Checkout
Vertical Stacking Operations	Vertical Splice LH2/PM
	Vertical Splice IU/LO2/IT
Final Integration and Functional Testing	Horizontal Stack
	Systems Tunnel Assembly and Inatall
	Engine Install
	Heat Shield and Engine Fairing Install
	Final Integrated Functional Testing
Miscellaneous Special Tooling and Transporation Equipment	N/A
*This assumes no design of the avionics boxes	

Table 2: Manufacturing development for SLS Core Stage

Main Propulsion System (MPS) Leveraging: As stated earlier, the SLS Core Stage development will dictate the critical path of the new SLS vehicle. Within the Core Stage, the critical path will depend on the Main Propulsion System (MPS), one of the subsystems within the Core Stage. The Main Propulsion System (MPS) is that subsystem on the Core Stage which receives propellant from the large cryogenic tanks and feeds those propellants to the engines for use. This critical path follows the development of the MPS, including the establishment of the MPS supply chain. The initial SLS Core Stage MPS will utilize three to five RS-25D engines that were utilized on the Space Shuttle. While the engine type and number for Ares US and SLS Core Stage differ, there is nonetheless much duplication of effort associated with the Ares US MPS development already performed. While the overall architecture of the MPS subsystem will be different, most of the component design and development efforts can be used directly. The supply chain is significant in this discussion because almost all of the component developments are associated with a Supplier. Specifically, components that are directly relatable are:

- Fill/drain Valves
- Vent valves
- Relief valves
- Isolation valves
- Pneumatic valves
- Ambient Composite Over-wrap Pressure Vessels (COPVs)
- Cryogenic COPV
- Pressure Control Module
- Re-Pressurization Module
- Regulators
- Recirculation Pumps
- Lines and ducts (modified for diameter/length/layout)
- LO2/LH2 Pre-valves (modified, but same sealing elements and actuators)

Much of the existing development of these components for Ares would be duplicated in a competitive procurement for SLS. Boeing and its suppliers are currently at a level of maturity with these components that would allow a lower (additional maturity over that already expended on Ares US) cost-to-complete on SLS for these component developments. In other words, the government has already performed effort on Ares MPS development, a part of which does not need to be repeated for SLS Core Stage should the government elect to use Boeing.

In addition, Boeing served as the technical expert to NASA on the design, development, manufacturing, testing and operation of the Shuttle Orbiter MPS (using the same RS-25D engines for SLS) to ensure its continued safety, flight readiness, efficiency and overall mission success. The effort was funded by the government over many years and Boeing is sufficiently familiar with the Orbiter MPS that a new contractor would need to re-learn at the government expense, thereby adding to cost duplication. Unique services that Boeing has provided to the Shuttle program range from designing new system modifications and upgrades to resolving day-to-day issues and mission anomalies.

This Ares I US MPS development knowledge base, coupled with specific Boeing expertise with the RS-25D engine details from an MPS perspective, would represent a duplication of cost if this effort were to be competed. This cost duplication is approximately \$49M. This cost is based on first estimating the percentage of the SLS Core Stage MPS development effort that would be required if Boeing were to continue with those extensible portions of the Ares US effort and proceed forward to SLS Core Stage MPS development. Multiplying this percentage by the total expected cost for MPS development (assuming the effort is started from the beginning) yields the cost that would be expected with Boeing performing the work. The cost difference between the total expected cost for MPS and Boeing expected Stages cost is the cost savings, or conversely the cost duplication that would occur should this effort be competed. In this case, a new contractor (associated with a new MPS design from the start) would be representative of that submitted under the SLS Broad Agency Announcement (BAA), under which the agency obtained information relevant to potential contractor costs for SLS development. NASA can avoid duplicating substantial costs associated with MPS development by contracting with Boeing. (Potential recovery of costs in a competition are discussed in the Cumulative Cost Duplication section below.)

Cumulative Cost Duplication: Award of a contract to any source other than Boeing for the work described above likely would result in substantial duplication of cost to the Government that is not expected to be recovered though competition. Cumulatively, the duplication of cost as described above is estimated to be \$98M to \$143M in addition to the additional costs that would be incurred as discussed under the heading of "Cost Impact of Delay" paragraph, given above.

These duplicative costs are not expected to be recovered through competition based upon an evaluation of the potential contractors and the determination that their ability to capitalize on similar or existing work is not nearly as significant as it is for Boeing. Boeing was selected for a large cryogenic (LOX/LH2) stage procurement in 2007 as part of a full and open competition with the same functionality in the US as in the SLS Core Stage. While it is true that the stage size is different between Ares US and SLS Core and Upper Stages, as is the engine complement, the same functionality exists between the two. Further, the Ares US solicitation produced the best value for producing a large cryogenic stage for the government. Moreover, there are companies that can show heritage and experience in some of the areas mentioned in the above sections, but none has both of the significant attributes of large cryogenic stage development (and associated tools, processes, and experience), and cryogenic MPS development with existing vendor supply chains for components that can be used on SLS Core Stage.

For the reasons specified above, NASA intends to utilize the existing Ares Upper Stage contract for the SLS Stages effort.

6. **Potential Sources.** The proposed contract action has been published on the NASA Acquisition Internet Service (NAIS) which included posting the Federal Business Opportunities as a pre-solicitation synopsis in accordance with FAR 5.201. No responses were received.

7. **Determination of Fair and Reasonable Cost.** A cost analysis will be performed as described in FAR 15.4. Boeing will submit a proposal that will be evaluated and negotiated by the Government. All sources such as Contracting Officers, Cost and Price Analysts, the Defense Contract Audit Agency (DCAA), and Government technical representatives will be utilized in the determination of a fair and reasonable cost. In addition, historical data established under the Ares I US Boeing contract will be used for cost comparisons, when applicable.

8. **Market Research.** Market research for the proposed acquisition was conducted via the Space Shuttle Program, the Ares I project, and associated technical analyses at MSFC. After extensive study of potential options, NASA has determined that Boeing is the only responsible source and no other source will satisfy the agency's requirements, given the duplication of costs and unacceptable delays inherent in using another contractor for this effort.

9. **Other Facts Supporting the Use of Other than Full and Open Competition.** The NASA Authorization Act of 2010 directed the Agency to develop, as rapidly as possible, replacement vehicles capable of providing both human and cargo launch capabilities to low-Earth orbit and to destinations beyond low-Earth orbit. The Act directed the Administrator to utilize, to the extent practicable, investments, workforce, industrial base and capabilities from the Space Shuttle Program (SSP), Orion, and Ares I projects for development of the SLS. Use of Boeing would comply directly with congressional guidance and intent.

10. **Interested Sources.** The proposed contract action was published on the NASA Acquisition Internet Service (NAIS) which included posting the Federal Business Opportunities as a pre-solicitation synopsis in accordance with FAR 5.201. No responses were received.

11. **Barriers to Competition.** The agency will consider a future competitive acquisition for Stages for an evolved vehicle at a later time. NASA will seek to obtain the appropriate level of data rights required to effectively compete the Stages in the future.

Anthony R. Lavoie
Manager, Stages Element Project Office

10/25/11
Date

I hereby certify that the above justification is complete and accurate to the best of my knowledge and belief. In addition, I hereby determine that the anticipated cost to the Government will be fair and reasonable.

George E. Pendley
Contracting Officer

10/25/11
Date

Concurrence:

Kim E. Whitson
Procurement Officer

10/25/11
Date

James R. Frees
Acting Chief Counsel

10/25/11
Date

Arthur E. Goldman
Center Competition Advocate

10/25/11
Date

William H. Gerstenmaier
Associate Administrator for Space Operations
Mission Directorate

25 Oct, 2011
Date

Sheryl Goddard
Agency Competition Advocate

31 Oct 2011
Date

Approval:

for Sheryl Goddard
William P. McNally
Assistant Administrator for Procurement

31 Oct 2011
Date

ACRONYM LIST

ASSY	Assembly
ATP	Authority to Proceed
BEO	Beyond Earth Orbit
BAA	Broad Agency Announcement
CDR	Critical Design Review
COF	Construction of Facilities
CS	Core Stage
COPV	Composite Overwrapped Pressure Vessel
DDT&E	Design, Development, Test & Evaluation
DRM	Design Reference Missions
ESD	Exploration Systems Division
FAR	Federal Acquisition Regulation
GRC	Glenn Research Center
HEO	Human Exploration and Operations Mission Directorate
IUA	Instrument Unit Avionics
JOFOC	Justification for other than full and open competition
JSC	Johnson Space Center
KSC	Kennedy Space Center
LaRC	Langley Research Center
LEO	Low Earth Orbit
LH2	Liquid Hydrogen
LOX	Liquid Oxygen
MAF	Michoud Assembly Facility
MFG	Manufacturing
MPCV	Multi-Purpose Crew Vehicle
MPS	Main Propulsion System
MPTA	Main Propulsion Test Article
MSFC	Marshall Space Flight Center
NAIS	NASA Acquisition Internet Service
NDE	Non-Destructive Evaluation
PDR	Preliminary Design Review
RCS	Reaction Control System
RFP	Request for Proposal
SDR	System Definition Review
SLS	Space Launch System
SSP	Space Shuttle Program
STR	Structures
TPS	Thermal Protection System
TVC	Thrust Vector Control
UCA	Undefinitized Contract Action
US	Upper Stage
U.S.C.	United States Code